Research Product 89-02

Implementing Embedded Training (ET): Volume 7 of 10: Embedded Training Test and Evaluation

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Manned Systems Group
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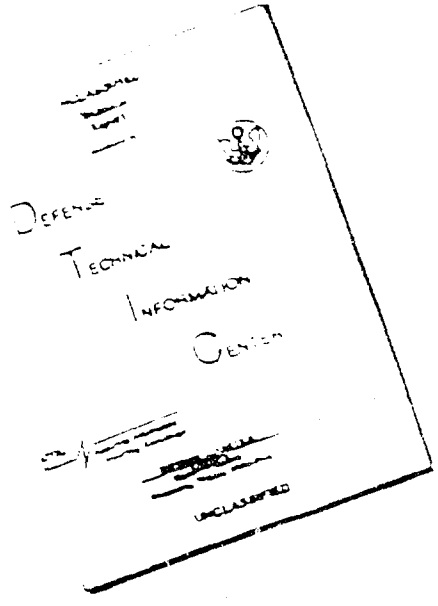

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This research product is one of a series of 10 documents produced by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) and the Project Manager for Training Devices (PM-TRADE). It offers guidance for combat and training systems developers, testers, and evaluators in planning and conducting a test and evaluation (T&E) program for embedded training (ET) as it is developed in concert with the operational system. ET-unique T&E issues and non-T&E needs are discussed in the context of the Army Streamlined Acquisition Program (ASAP) and the Life Cycle System Management Model (LCSMM). The report offers specific suggestions for the preparation of the Test and Evaluation Master Plan (TEMP) for ET components. Keywords:

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Implementing Embedded Training (ET): Volume 7 of 10: Embedded Training Test and Evaluation

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Human Performance Effectiveness and Simulation

This document is Volume 7 in a series produced by the Army Research Institute for the Behavioral and Social Sciences (ARI) and the Project Manager for Training Devices (PM TRADE). The series consists of 10 related documents that present guidance for combat and training systems developers, including Army Materiel Command (AMC) and other materiel developers and entities, Training and Doctrine Command (TRADOC) Combat Developers and Training Developers, and contractor organizations involved in system development or developing technological thrust areas under independent research and development (IR&D) programs.

This series of documents includes guidelines and procedures that support the effective consideration, definition, development, and integration of embedded training (ET) capabilities for existing and developmental systems. The 10 documents share the general title of Implementing Embedded Training (ET), with specific, descriptive subtitles for each document. They are as follows:

1. Volume 1: Overview presents an overall view of the guidance documents and their contents, purposes, and applications, including a discussion of the following:

   a. what the total training system concept, including embedded training, is;

   b. how training systems must develop within more general processes of materiel system development;

   c. how embedded training must affect this relationship; and

   d. what the content and uses of the remaining documents in the series are, as well as their relationships to the training systems development and acquisition processes, and how to use them.

2. Volume 2: ET as a System Alternative provides guidelines for the initial decision on whether ET should be further considered as a training system alternative for a given materiel system. It also includes guidance on considering ET as an alternative for systems under product improvement or modification, after fielding.

3. Volume 3: The Role of ET in the Training System Concept contains guidance for the early estimation of training system requirements and the potential allocation of such requirements to ET.

4. Volume 4: Identifying ET Requirements presents procedures for defining ET requirements (ETRs) at both initial levels (i.e., before initiating systems development) and for revising and updating initial ETRs during system design and development.

5. Volume 5: Designing the ET Component contains analytic procedures and guidance for designing an ET component concept for a materiel system, based on specified ETRs.

6. Volume 6: Integrating ET with the Prime System discusses considerations, guidance, and "lessons learned" about factors that influence the effective integration of ET into materiel systems.

7. Volume 7: ET Test and Evaluation presents guidance for defining the aspects of the ET component (test issues) to be addressed in prototype and full-scale system testing.

8. Volume 8: Incorporating ET into Unit Training provides guidance for integrating ET considerations and information into unit training documentation and practice.

9. Volume 9: Logistics Implications presents helpful information on key logistics issues that should be addressed in the context of ET integration with prime item systems.

10. Volume 10: Integrating ET into Acquisition Documentation provides guidance on developing the necessary documentation for, and specification of, an ET Component of a prime item during the Army's systems development and acquisition process. This document examines the Life Cycle System Management Model (LCSMM) and the Army Streamlined Acquisition Process (ASAP) and describes where and how to include ET considerations in the associated documentation. It also describes where and how to use the other volumes in the ET guidelines series to generate the information required for the acquisition documentation, and provides guidance in preparing a contract Statement of Work for an ET Component to a prime item system.

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IMPLEMENTING EMBEDDED TRAINING (ET):
VOLUME 7 OF 10: ET TEST AND EVALUATION

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IMPLEMENTING EMBEDDED TRAINING (ET): VOLUME 7 OF 10: ET TEST AND EVALUATION

INTRODUCTION

The purpose of this volume is to provide a general approach and guidance for Test and Evaluation (T&E) of the embedded training (ET) subsystem during system development. System development which includes integrated ET is relatively new to the Army acquisition process. Many existing regulations and specifications have not, as yet, been updated to reflect the ET development process integrated with the system development process. The series of ET guideline documents, of which this document is a part, structures and proceduralizes the process. These ET development procedures may become formalized and included in acquisition documentation at some later point in time. This volume discusses the major issues of ET T&E.

ET imposes a number of new and significant requirements on each of the stages of system development, especially in the early stages when system hardware, software, and operational concepts are being formulated and refined. The training T&E requirements imposed on the system development environment are particularly unique from the perspective of training developers. Training T&E requirements assume an urgency that is not present when ET is not a part of the system development process. T&E for integrated ET is in its infancy. Little experience has been gained to guide and structure the T&E process because at this time no Army procurements that included ET requirements based on defined system-specific training requirements have been brought through the production phase. It is expected that the basic guidelines offered here may, in the future, be expanded through applying lessons learned.

Overview

The overall purpose of this guideline is to present guidance on how to incorporate unique ET considerations into ongoing T&E procedures for the developing system. This document attempts to highlight those added T&E considerations which will be beneficial--even essential--to the overall process which integrates ET (along with other functional components) into an efficient and cost-effective end-item. Elements that are required for general T&E are not covered here unless they are particularly critical to the ET T&E effort. This volume provides basic information for the T&E planner to deal with the ET component. Other volumes in this series, notably Volumes 4, 5, 6, and 8, may provide greater insight into the ET development process.

No cookbook approach to planning and conducting tests and evaluations relevant to ET can be offered. The variations in procurement practices, end-item systems, training systems, and ET subsystem designs are far too great to permit a simplistic approach. What is provided is an ET-oriented approach to T&E which can add to the effectiveness of a T&E program.

As indicated in Figures 1 and 2, this guidance is specifically related to the principal stages of the acquisition process prior to Milestone III. Because of the variability in development schedules, it is not useful to deal with the acquisition process in greater detail.

This document is divided into three major sections, plus three Appendixes. This section provides a discussion of the goals appropriate to T&E of ET designs as they evolve and a brief discussion of the advantages of the concept of Continuous Evaluation (CE).

The second section of this document outlines the content and format requirements for preparing and updating ET inputs to a Test and Evaluation Master Plan (TEMP). The guidance included in this section is applicable to different systems and to TEMPs prepared at different stages of system development.

The third section discusses three issues that distinguish ET testing from the traditional testing appropriate for all developing systems. Approaches for addressing these issues are presented. Typically, training is not tested as part of the prime system development process. However, ET is an integral part of the end-item configuration. This means that ET must be tested as it is developed, since with ET the degrees of freedom to add to or modify the nature of the training decrease rapidly as the design of the overall system is performed.

Appendix A consists of a reproduction of the material in AMC Pamphlet 70-2, Materiel Acquisition Handbook, Chapter 13, Test and Evaluation. This material describes T&E procedures in terms of the Army Streamlined Acquisition Process (ASAP).

Appendix B discusses two issues which, while not a part of traditional T&E, impact the training system development process and its quality control program. These issues are: (1) need for early and continuous involvement of training developers with ET responsibility as essential members of the system design team; and (2) need for an oversight process, in addition to conventional T&E, that assures that the processes needed to define, design, and implement effective ET are actually conducted during system development.

Appendix C provides a list of abbreviations and acronyms.

LCSMM

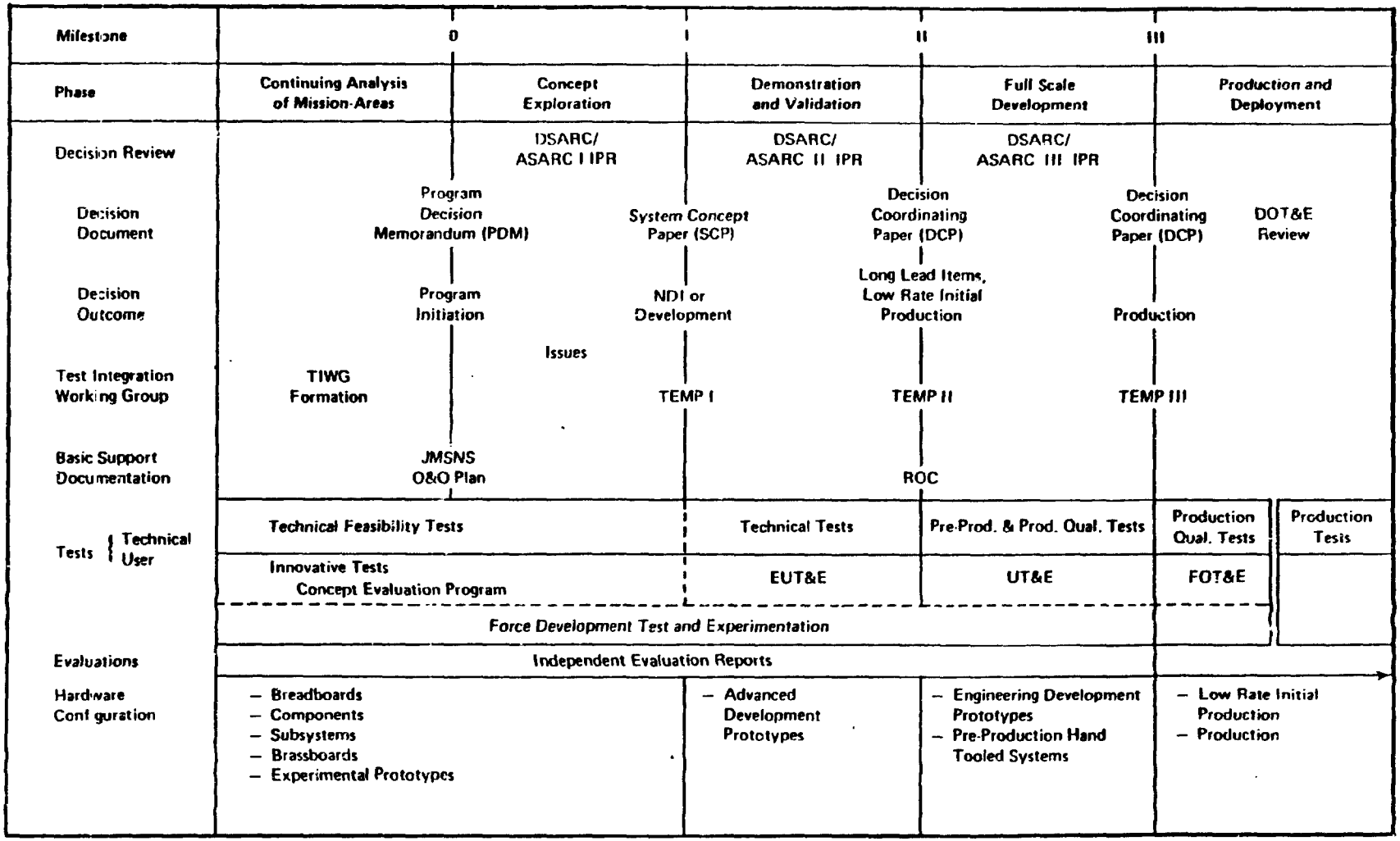

Figure 1. The Life Cycle System Management Model acquisition process and associated test and evaluation events.

ASAP

Milestone	0		I/II		III	
Phase	Requirements and Tech. Base		Proof of Principle	Development Production Prove Out		Production and Deployment
Decision Review			DSARC/ASCARC IPR I/II			DOT&E Review
Decision Document		Program Decision Memorandum (PDM)		System Concept Paper (SCP)		Decision Coordinating Paper
Decision Outcome		Program Initiation		NDI/Development Long Lead Items, Low Rate Initial Production		Production
Test Integration Working Group	TIWG Formation		Issues	TEMP I/II		TEMP III
Basic Supporting Documentation		JMSNS O&O Plan		ROC		
Tests: Technical	Technical Feasibility Tests		Development Tests	Pre-Prod. & Prod. Qual. Tests		Production Dual Tests / Production Tests
Tests: User	Innovative Tests Concept Eval. Program		EUT&E	UT&E		FOT&E
	Force Development Test and Experimentation					
Evaluation	IERs			IERs		IERs →
Hardware Configuration	– Breadboards – Components – Subsystems – Brassboards – Experimental Prototypes – Surrogates			– Development Prototypes – Hand Tooled Prototypes		– Low Rate Initial Production – Production Systems

Figure 2. The Army Streamlined Acquisition Process and associated test and evaluation events.

Goals of ET Testing

The ultimate goal of ET T&E is to assure effective soldier performance under combat conditions in the field. T&E subgoals for ET match the testing goals stated in Army Regulation (AR) 70-10, Test and Evaluation During Development and Acquisition of Materiel. These goals are:

1. Demonstrate how well a materiel system meets its technical and operational requirements.

2. Provide data to assess developmental and operational risk for decision making.

3. Verify that technical, operational, and support problems identified in previous testing have been corrected.

4. Ensure that all critical issues which could be resolved by testing have been adequately considered.

AR 70-10, along with AR 71-3, User Testing, defines the requirements for system testing during acquisition. This test and evaluation process is illustrated in Figures 1 and 2. These figures, adapted from an older version of DARCOM Pamphlet 70-2, Materiel Acquisition Handbook, portray the T&E process as it occurs in the ASAP, as well as in the traditional Life Cycle Systems Management Model (LCSMM). The discussion of relevant T&E issues for ET is referenced to the processes and events shown in Figures 1 and 2. Figures 1 and 2 also relate ASAP ET T&E activities to those appropriate within the LCSMM.

This document is designed for both Government and contractor personnel responsible for the specification of test issues and the conduct of tests. The contractor will be responsible for much of the training effectiveness evaluation as the ET design evolves and as specific courseware is generated. Traditionally, both Government and contractor T&E activities emphasize the verification of equipment operation in accordance with design specifications. This will continue to be true for systems involving ET. Contractor ET T&E, in addition, should particularly concentrate on verification of the feasibility of ET design approaches, the overall system compatibility of the ET hardware and software, and the effectiveness of specific modules of courseware.

The nature of the ET design process implies that if ET T&E is rigorously applied during development, the resulting ET subsystem will be operationally suitable. However, if problems are not identified and rectified until system fielding, the degrees of freedom for achieving successful "fixes" will be reduced. Therefore, this volume is particularly concerned with ET T&E during the development process.

As is true of the end-item itself, the results evaluated by ET T&E are greatly impacted by the scope and process of the ongoing analysis

and design efforts. The assessment of some of these factors is discussed in Appendix B. These are issues which are critical to the successful integration of ET with the end-item system. Since many ET analyses must be completed prior to end-item design, this may make early performance assessment (or at least some form of directed oversight) appropriate, to assure that ET design is effectively dovetailed with the prime system design, even though this is not when training is usually assessed.

The Continuous Evaluation (CE) Concept and Activities for ET

In its fully embedded form, ET requires that the training hardware and software be an integral part of the complete operational system, whether it is a combat system or a combat-support system. This means that the design of the ET subsystem must be accomplished at the same time and in concert with the design of the prime item or "mission" system. Because of the complexity of most modern systems for which an ET approach should be considered, simultaneous development is necessary in cases even when the ET subsystem will be adjunct or appended rather than built in. The degree of interaction necessary between training, operational software, and databases, and the fact that ET is presented to the soldier at his work station, link the training function with all other system operational functions for design purposes.

The fact that the ET development must be continuously integrated with the design process begs the question of testability of the product. If the T&E effort is instituted only after a complete training product is available, and the product is found wanting, what can be done? It is too late to institute major changes. Continuous Evaluation, a new concept under exploration by the T&E community, may provide the answer.

Continuous Evaluation (CE) is a concept designed to facilitate system development and thorough performance evaluation.[1] Unlike the traditional approach, wherein the majority of systematic evaluation occurs during scheduled periods, CE offers the opportunity for much earlier assessment of appropriate ET design. CE enables all portions of the developing system to be assessed and tuned as part of the ongoing design process to achieve maximum effectiveness. This adjustment can be applied to the ET subsystem in the same way it is applied to hardware and software subsystems. CE is increasingly valuable as a function of system complexity; it is also increasingly valuable as a function of the complexity and sophistication of the system's ET component.

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[1]Kaplan, J. (1985). Continuous evaluation: A concept. Journal of Operational Test and Evaluation. VI(4).

Early on in the evaluation process for ET, before there are major assemblies of hardware and software, system functions assigned to ET can and should be assessed function-by-function in a process of formative evaluation. This process should utilize any component performance data which exist, and logically predict performance for all training functions. As design proceeds, this process is iterated at successively greater levels of system and ET subsystem integration to confirm that planned functions are feasible and cost effective. This same component-by-component, subassembly-by-subassembly, subsystem-by-subsystem evaluation approach can continue to be followed as function analysis evolves to component analysis. Initially, functions are modeled utilizing data derived from rational analysis. Later, these "soft" data can be replaced by actual test results. As the testing process commences, the design can be reconfigured to continually keep the differences between needed performance and actual ET subsystem capability as small and manageable as possible.

The nature of appropriate T&E is to assure effective ET design integration and functional capability changes as the system design evolves. Six types of T&E activities are appropriate:

1. Oversight to assure that training system developers work in concert with operational system designers.

2. Oversight to assure that analyses done to configure and size the operational system and the ET subsystem are being appropriately accomplished.

3. Evaluation to confirm that the ET design will function as needed to deliver the required training.

4. Evaluation to demonstrate that the designed prime system capabilities (hardware and software) can accommodate the anticipated ET.

5. Test to assure that the developing ET courseware will teach when and where needed (user test [UT], skill acquisition, and skill sustainment).

6. T&E to confirm that the ET component evolves successfully with the changing operational system.

The formal TEMP is configured to deal with activities 3 through 6 above. Items 1 and 2 are not normally in the purview of T&E, and, while extremely important, are not discussed in the main body of this report. They are discussed in Appendix B.

The TEMP is one key to successful ET development. As indicated in Figures 1 and 2, the TEMP, in its successive iterations, structures the overall T&E program during system development. Insightful integration of T&E planning for ET with T&E for the prime system can assure that the ET portion of the training system will function to match human

performance (individual and crew) to overall system performance. The next section of this document discusses the requirements for, and preparation of, the ET portions of a TEMP.

INTEGRATING ET INTO THE TEST AND EVALUATION MASTER PLAN (TEMP)

The TEMP is "...the basic planning document for all T&E related to a particular system acquisition..."[2]. This document establishes the requirements and timetable for T&E during the acquisition process. It is the working document produced for T&E guidance by the Test Integration Working Group (TIWG). The TEMP documents the goals of T&E investigations, the T&E schedule, and projected resources.

Foundation of the TEMP

The TEMP changes during the acquisition process. If the LCSMM is in place, then there are three iterations of the TEMP: one at Milestone I, to plan for T&E during Demonstration and Validation; one at Milestone II, for T&E during Full-Scale Development; and one at Milestone III, for T&E during Production and Deployment. If the ASAP is in place, then TEMPs I and II are combined and developed for T&E during Development Production Prove Out, while TEMP III again plans for Production and Deployment.

ET Considerations in the TEMP

The purpose of the TEMP is to identify the technical and operational issues relevant to T&E. Ideally, each test should be identified and its goals specified. These goals are stated in AMC/TRADOC Pamphlet 70-2, Materiel Acquisition Handbook (Appendix A). With respect to training, the goals of T&E are to determine that training requirements are met, and to establish compatibility and interoperability with the Army and other services (AMC/TRADOC Pam 70-2, pg. A-3, point d.). However, these goals are insufficient with respect to T&E for ET.

By the time the development and prime system acquisition process is complete, more than simply the ability of ET to meet training objectives must be established. To establish the proper goals for ET T&E, it is necessary to consider goals originally intended for the operational capability of the prime equipment. These additional goals are to assess: operational suitability, operational effectiveness, and readiness. Applying these goals to ET, it is necessary to address:

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[2]HQ, Department of the Army. (1986). Research, Development, and Acquisition: Test and Evaluation (AR 70-10, 30 April 1986).

1. ET suitability. Suitability means whether ET is an appropriate training method for this system and its use concept, and whether the correct soldiers are targeted to use it.

2. ET effectiveness. Effectiveness includes adequacy of content coverage, success of training transfer to job performance, and related issues.

3. The ability of ET to contribute to soldier readiness. This implies that ET must target and affect the particular aspects of soldier performance that must be trained or sustained to improve force readiness.

This change in goals is necessary because development of ET does not take place following equipment development as has historically been the practice in traditional training system development. Instead, ET is developed in concert with prime equipment development. As has been discussed, once the equipment is developed, a large part of the functionality to implement ET is fixed. If any needed elements to implement ET functions are omitted, it is unlikely that they can be added-in economically later. This alteration in the phasing of training development relative to ET is dealt with in Volume 10 of this series (Integrating ET into Acquisition Documentation). ET must also be tested and evaluated on a schedule in concert with the development of the prime system hardware itself.

Integrating TEMP With Continuous Evaluation

The CE approach means that parts of a materiel system are evaluated for their ability to achieve required goals as they are developed. This concept, recently implemented for hardware and software, should be implemented for ET as well. There are three issues that pertain to implementing a CE approach to ET. These issues must be reflected in TEMP decisions, and are referred to later in this section. They are:

1. ET must be designed in concert with the materiel system design, whether ET is fully integrated or is an adjunct system.

2. Technical testing of ET must occur while there is still time to remedy deficiencies.

3. ET should be tested piecemeal (i.e., as elements of the ET capability evolve to points where they can be meaningfully tested; testing should not be delayed until all elements of ET are fully developed), as the materiel and ET designs progress.

ET Goals

As the first step in developing the TEMP for ET, the training developers (whether or not members of the TIWG) should clarify the goals of ET for the particular system under development to the TIWG. This should be done whether ET is directed from higher authority or whether it is one of a number of training methodologies under consideration for the new system. This clarification will help the TIWG understand the importance of different aspects and applications of ET, and to make the necessary testing decisions. To provide knowledgeable resources and oversight for considering the testing of ET and other training system elements, it is suggested that the TIWG include voting representation from the training community. This might include membership from the Directorate(s) of Training and Doctrine (DOTD) of the proponent school(s).

The following questions will help to establish the ultimate performance expectations for the ET component. These questions probe key points to be resolved prior to specific T&E planning:

1. Is ET intended for acquisition training?

    a. If the answer is yes, will ET be used at institutional sites, unit sites, or both?

    b. Which training capabilities will be used at each site?

    The content of acquisition training is often quite different from the content of sustainment training. The former is heavily oriented toward the initial acquisition of skills at the entry job performer level; sustainment is usually concerned with skill integration in the operational setting, and the refinement of already acquired skills. Sustainment and related training roles (e.g., skill level upgrade, train-up of replacement personnel in mobilization situations) may be associated with needs for higher fidelity levels and larger varieties of training scenarios when simulation is involved.

2. Is ET intended for sustainment training at unit sites?

    a. If ET is intended for unit sustainment training, will training be individualized for particular sites and applications (e.g., scenarios customized for the location of deployment)?

    If training is intended for unit sites, then it will have broader application if it does not rely on instructors as active, real-time performance monitors. Training designed for institutional application can rely to a greater extent on instructors to perform evaluations and deliver feedback.

3. Are there identifiable sets of training objectives?

   a. For different types of personnel (e.g., operators versus maintainers)?

   b. For different levels of training (e.g., gunner versus crew chief, MOS XXX10 versus MOS XXX50)?

The types of trainees will have a strong bearing on the types of T&E that are developed. At various points in development, ET must be evaluated for each type of trainee, since the types of tasks trained, and even the hardware used in training, may differ for different job categories. For example, a chief of section may utilize ET that presents battle scenarios on a display, while a maintainer may utilize ET built into a separate diagnostic device that attaches to the actual equipment.

4. Is ET intended for soldier and unit preparedness evaluation (e.g., ET measurement capabilities used as part of evaluations in the ARTEP process)?

If soldier and unit preparedness evaluation are intended, then T&E must ensure that provision is made for features necessary to achieve valid evaluations. The following features are important to all training, but are especially critical to evaluation:

   a. Data collection and recording capabilities for performance assessment must be able to deal with large amounts of data.

   b. Performance data must be kept secure from participants and secure from tampering.

   c. A range of scenarios varying in difficulty must be available, so that the full range of individual and unit performance can be measured.

   d. A variety of scenarios must be available at each level of difficulty, so that individuals and units cannot familiarize themselves with the test scenarios and raise their scores solely due to this familiarity.

The first two of these features may be evaluated during technical tests of the ET subsystem. The last two features may be evaluated during First Article Testing (FAT) during Production and Deployment.

Content of the TEMP

Now that ET T&E has been put in perspective with the TEMP and related evaluation processes, the specifics of the TEMP with regard to ET are presented. The TEMP is a dynamic document, changing throughout the course of the system development and procurement process(es). In addition, different procurements will have more or less specific TEMPs, and the particular points that the TEMP deals with will differ across procurements. The following discussion presents an ideal situation in which ET is a significant aspect of the procurement. Accordingly, the discussion notes many points where ET should be dealt with. It is the option of the TIWG to decide how much of this content should be included in a given TEMP.

Specific guidance on the format of a TEMP is provided in DOD Directive 5000.3M-1, Test and Evaluation. The TEMP is divided into five parts (shown in Roman numerals):

Part I. System Details and Description.

Part II. Program Summary.

Part III. Technical Test and Evaluation (TT&E) Outline.

Part IV. User Test and Evaluation (UT&E) Outline.

Part V. T&E Resources Summary.

Administrative information, which comes first, is unchanged by ET. There are also some schedules that are appendixes to the TEMP. These are also unchanged by ET. The TEMP paragraphs to be discussed in terms of ET are:

1.	System Description	(Part I)
2.	Required Technical Characteristics	(Part I)
3.	Management Summary	(Part II)
4.	Integrated Schedule	(Part II)
5.	Critical Technical Issues	(Part III)
6.	TT&E Events	(Part IV)
7.	UT&E Events	(Part IV)
8.	Test Resources Summary	(Part V)

System Description

The system description should include a statement of the fact that ET is part of the system. For TEMP I in the LCSMM, this may be a statement that ET is under consideration. Interfaces should be described for adjunct or strap-on ET, and for any planned netted operations (i.e., interconnecting the ET components of two or more systems to enable collective training above the operator or crew level) to be considered for inclusion in the ET concept.

ET should be considered a unique characteristic for Army equipment at the present time. This determination must be made in historical context, however. Once ET becomes commonplace, it may no longer be appropriate to call it unique. However, the procedures required for integrating and testing ET are new enough that it is appropriate to denote ET as a unique feature.

Required Technical Characteristics

ET should be named as a required technical characteristic of the prime system. Some specific ET technical characteristics are specified in the following list. The characteristics may be presented in tabular form:

1. Allowable times to transition into and out of ET.

2. Allowable logistics burden for ET and any appended components. Appended components allow ET when certain support components (e.g., scenario generator) are added to the system temporarily.

3. Levels or types of training to be delivered by ET (e.g., acquisition, sustainment, expert).

4. Number of scenarios and the required variability of training (e.g., location-specific scenarios, expert-level scenarios). Also, sufficient variety to prevent memorization and boredom.

5. Training content or topics (e.g., failure modes, multiple targets, maintenance).

6. Allowable extent of dependence on instructors or training managers during ET sessions.

7. Required level of fidelity of simulations. Each aspect should be dealt with in as much detail as possible (e.g., visual scene fidelity, representation fidelity of communications; dummy rounds). For TEMP I, this specification will probably be functional rather than technical (e.g., visual fidelity good enough to allow detection [or identification, as appropriate to the scenario] of a helicopter

at the appropriate distance for missile launch), but technical specifications are preferred. The fidelity parameters for each aspect of simulation should be stated clearly enough to allow piecemeal evaluation. For example, visual simulations should specify display resolution, movement, verisimilitude, etc. This way, the suitability of software, display generators, monitors, etc. can be determined.

8. Performance evaluation and assessment capability.

9. Performance data security.

10. Feedback in support of effective learning.

11. Adaptability, so that the system can respond to soldier performance and adapt the presented training materials to strengthen weak areas.

Management Summary

This is the first section of Part II, Program Summary. This section should specify the agency(ies) responsible for ET T&E.

Integrated Schedule

The integrated schedule is a critical part of the ET T&E effort, because ET T&E must take place concurrent with system T&E. Without this coordination, it will be difficult or impossible to implement changes to ensure satisfactory ET. In the past, usual practice has been that training products have been procured separately, and, hence, have had separate TIWGs that include training-knowledgeable members. The normal time for developing and testing training has traditionally been after the system concepts, hardware, and software are firm. At the present time, the non-training-oriented members of the TIWG may not be aware of the requirement to address ET and integrate it into the testing issues and schedule. Training representatives must ensure that the proper elements are included in the schedule at the proper times.

The ET-related part of the integrated T&E schedule should take note of scheduled hardware, software, and training delivery dates, and hardware and software test dates. These should be used to forge a continuous evaluation program for ET, in which each component related to ET is evaluated for its ability to fulfill its ET functions at the same time it is evaluated for its ability to fulfill its operational functions or mission. This relationship is reflected below in TEMP I, Activity 2, and TEMP II, Activity 1.

TEMP I should plan for the following activities:

1. Establish overall goals of ET (training audience, collective and individual tasks to be trained, training sites, introductory vs. sustainment, level of proficiency to be achieved). Perform PTEA.

2. Establish what equipment (real or models) will or can be available with ET capability that can be evaluated, and on what schedule. The delivery schedule for ET-related components may dictate the order in which piecemeal evaluation for ET takes place. To ensure that deficiencies can be corrected, each relevant piece of hardware and software should be evaluated against its ET-oriented functional requirements. Simulation-related items must have appropriate fidelity; interfaces must allow ET access to required hardware and software for simulation and performance assessment; hardware must have provision for varied ET scenarios; soldier-machine interfaces must provide for rapid transitioning into and out of ET; and so forth.

3. Determine whether ET will support user test (UT) of the prime system (not just ET evaluation).

4. Establish that personnel will be available as test subjects for ET performance evaluation during UT.

5. Arrange for subject-matter experts (SMEs) to assist in formative evaluations of training system components in concert with CE. SMEs may also be useful as overseers of summative performance evaluations of ET (in later test events).

6. Evaluate ET training objectives to ensure complete coverage of all areas requiring ET.

7. Verify feasibility of ET approach, based on prime system hardware configuration. This is the essence of the verification that ET can be "embedded."

Items 1, 2, 3, and 7 are aimed at ensuring ET suitability. Items 4, 5, and 6 are aimed at ensuring training effectiveness. Item 4 will also contribute to evaluating ET's contribution to soldier readiness.

TEMP II should plan for the revision and completion of the above activities, especially point 6. In addition, the following activities should be planned (the order reflects the approximate sequence in which the actual activities will take place):

1. Schedule ongoing developmental review of the ET courseware material. Periodic reviews should cover pieces of ET as

they are produced. Hardware capabilities are an important subject of this review process. If possible, schedule exercises which demonstrate how ET will utilize the hardware in an actual training context. For instance, it may be possible to select one scenario for one lesson and prepare that scenario completely--text, visual, response processing, feedback, etc. This scenario would then be presented to SMEs, trainers, and perhaps users to evaluate training approach, fidelity, and adequacy of training implementation. These reviews may take place in-plant.

2. Establish which aspects of the ET component can be tested with performance evaluation, given the expected level of ET and system development.

3. Specify experimental design of performance (user) tests.

4. Schedule subjects for in-plant performance evaluation of the ET component.

5. Schedule equipment for performance evaluation of ET component.

6. Evaluation of ET courseware outlines or lesson plans for adequacy.

7. SME review of ET training material.

8. Prior training for test subjects for the performance evaluation of sustainment ET.

9. ET performance (user) evaluation.

All items will help to establish ET effectiveness. Items 2, 3, 4, 5, 8, and 9 are also aimed at evaluating ET's contribution to soldier readiness.

Critical Technical Issues

This is the first section of Part III of the TEMP, the T&E outline. This section is the Technical T&E (TT&E) Outline. Training issues may be subsumed under a subheading called Training.

The issues noted above as required technical characteristics should be scheduled for test in this section. Some tests can be accomplished as part of an in-plant test of the ET component, using a physical model of the actual system that contains the ET component. However, there is a high probability that ET courseware will not be completed by the early test dates. The TIWG should direct the contractor to develop ET courseware necessary for the in-plant test such that the critical elements of the prime system and its ET

component can be evaluated. This approach is in keeping with the CE concept of piecemeal testing to ensure timely recommendations for revision to remedy deficiencies.

As part of its input to the procurement contract, the TIWG should ensure that there will be testable material to allow evaluation of each critical part of the ET component. Attention should be paid to the following issues:

1. Quality of required simulation. Is the representation and content of visual material satisfactory?

2. Has provision been made for netted operations? It may be impossible to test the achievement of netted operations until a quantity of testbed articles or even operational system prototypes have been produced.

3. Is the human interface for ET satisfactory in all respects for all ET functions, from ET initiation, through training operations, to return to operational mode? Has the interface been designed to assure no negative transfer and no confusion regarding which mode the system is in?

4. Does trainee performance assessment capability exist and has provision been made for instructors or monitor student performance?

5. Is the general nature of training feedback during ET acceptable (frequency, immediateness, completeness)?

6. Is the required range of training provided (acquisition, sustainment, etc.)?

7. Has provision been made to vary training content?

8. Does the system provide safe transition between training and operational modes?

TT&E Events. In some TEMPs, there are specific sections dealing with particular test events. ET T&E planners should make every effort to ensure that specific ET tests and evaluations are included in the appropriate test events. This is very important because, as has been noted, ET is not yet second nature to the various members of the TIWG or to system managers. One critical event is an early look at training capabilities when the system breadboard is reviewed for other technical issues.

Critical Operational Issues

This is the first section of Part IV, User Test and Evaluation (UT&E). The operational issues will be tested in performance (user) tests, involving actual troops.

This test should be treated as if it were a long lead-time item, because the evaluation requires suitable Army personnel as test subjects. Specifically, a test of ET intended for initial skills acquisition training should include at least some soldiers who are representative of the population to be trained, in terms of aptitude, prior training, and unfamiliarity with the new system or related systems. The government agency that will provide these personnel must also be appraised of the location of the tests, so that suitable travel orders and arrangements may be made. Ordinarily, the earliest opportunity for performance tests will be at the contractor's plant (in-plant test), necessitating TDY. The TEMP should also specify the schedule for test personnel involvement. Often, only limited numbers of test subjects can be trained at one time using ET on the test system.

Another issue to be considered during development of the TEMP is whether it is useful and feasible to contrast ET with alternative training methodologies. That is, should another methodology be used to train soldiers and the results contrasted with ET in terms of: transfer of training, time to train, or cost to train? This type of contrast is not usually performed, but the capability may be inherent in the test situation if some are to be trained using other training methods, perhaps for FOTE or Early User Test and Experimentation (EUT&E), while others are to be trained using ET for ET evaluation. A contrast should be considered if the data appear to be comparable, to help in the ultimate decision about how to implement ET.

Test Limitations. This topic is sometimes included as a sub-subsection in the TEMP under UT&E. An important issue for performance testing is the availability of suitable equipment for T&E purposes. This issue is dealt with elsewhere in this document. TEMP I should specify the type of equipment and capabilities required for performance testing of ET. Schedules and duration of tests must also be specified, so that ET testing can be coordinated with other test requirements.

When breadboard, brassboard, or special test mockups are to be used for EUT&E of ET, they must first be evaluated for suitability. These evaluations may be part of TT&E. The particular issues to be considered are the environmental fidelity of the ET testbed (i.e., the similarity of the ET testbed to the intended ultimate system environment), and the extent to which the current quality of ET represents the ultimate quality that will be part of the delivered system.

UT&E Events

If there is to be an in-plant test, possibly using a brassboard or other special testbed for performance testing, then this should be specified as a system-operational issue in the TEMP. If the testbed is not dedicated to ET, then adequate time must be scheduled on the existing testbed for ET performance testing.

Experience has shown that the amount of time required for ET performance testing is often underestimated. First, the testers must receive training on how to use the system before they can evaluate how well it trains user subjects. This training may be part of a regular schedule of training for other purposes, but it must be conducted early enough for the performance test group to plan its evaluations. Second, the test planners must assess how long the training will take, and how many users can receive it during any given time period. Third, the test planners must establish how much training a user can be expected to absorb in a given period of time. In actual practice, ET is likely to be spread over a long time period, but for user testing this time period must be compressed. Often, the limited availability of training or test time will necessitate separate T&E or using different test subjects (personnel) for different training functions or operational modes.

Test Resources Summary

This section of the TEMP is likely to be fairly substantive for ET T&E, because a number of special resources are required for these activities. More important, the contractor, and perhaps even some government personnel, may not see these resources as directly relevant to the procurement of the prime item system. Their real relevance is to ensure that the prime item system will be used properly by soldiers. The specification of a resource presupposes adequate time and access to that resource (not always the case unless so stated). These resources are:

1. ET demonstration capability at the breadboard or brassboard stage of development (Demonstration and Validation or Early Development Production Prove Out).

2. Front-end training analysis products delivered soon enough to perform formative evaluations on them (e.g., training objectives, courseware outlines).

3. Piecemeal access to hardware, software, and training material directly related to ET implementation as needed for continuous evaluation.

4. SMEs for evaluation of courseware and objectives, evaluation of testbed adequacy, and for evaluation of physical suitability of the final ET configuration.

5. ET testbed during late Development Production Prove Out or Demonstration and Validation, and Full-Scale Development.

6. Suitable subjects for performance (user) testing (e.g., in-plant testing). Special attention must be paid to the time period over which subjects required for evaluation of sustainment training may be needed (they may have to be

trained at one or more points in time and retrained and retested one or more months later).

7. Suitable preliminary training for performance test subjects, especially for sustainment testing. It may be desirable to provide comparison training using alternatives to ET to determine whether ET affords a benefit.

8. Data collection hardware and software included in the test bed to allow automatic data collection during the performance (user) test.

EMBEDDED TRAINING TEST AND EVALUATION ISSUES AND APPROACHES

There are three major T&E issues derived from the TEMP and related directly to the T&E applications cited earlier, in addition to planned general critical issues (which can be extracted from DOD Directive 5000.3, Test and Evaluation). Issue 1 below involves T&E applications 3 and 4 on page 7, while issues 2 and 3 relate to applications 5 and 6. These three issues are:

1. The impact of ET design on the prime system design.

2. The problem of T&E for sustainment training.

3. The requirements for ET performance testing.

Resolution of these issues is neither standardized nor simple. What is an appropriate approach for a particular issue on one system is often not appropriate for the same issue as it arises in the development of another system. However, all of these issues and approaches are important and require attention. To the degree that they are ignored, system testing will be deficient, and system performance can be degraded.

Existing regulations and specifications do not mandate specific resolution of these issues. The objective of this discussion is to bring the issues to the attention of system development and evaluation personnel, so that effective tradeoffs and T&E decisions can be made.

Issue Number 1: Impact of Embedded Training Design on the Prime System

Effective integration of ET, whether it is appended onto or built into an operational system design, will impose changes to the total operational system; changes which would not occur if ET were absent from the overall system design concept. The design aim is to maximize the training potential of the ET component with minimum effect on the operational system. System operational capability cannot be compromised. The system, whether a weapon system or a support system, must meet its mission requirements. However, there are broad areas of feasible tradeoff and compromise in which characteristics and capabilities of the total operational system can be adjusted to maximize both operations and training. Generally, the tradeoffs which must be accepted to achieve effective ET include those listed below.

Design Tradeoffs

Maintenance load. In most cases, using the operational system for training will result in higher use factors and increased hours of operation. This, in turn, can lead to a greater number of failures and to an increased maintenance load to counter them. However, experience indicates that maintenance loads can be minimized by concentrating the high-use areas on system components which are mainly electrical or electronic. Actual usage data indicate that only when increased use involves mechanical "high wear" hardware movements (e.g., rotating a tank turret) is there potential for unacceptable maintenance load. The T&E program must verify that ET integration does not compromise operational reliability.

Logistics support requirements. The addition of an ET subsystem will impose additional maintainer requirements. By and large, ET subsystems involve the same kinds of equipment and components which make up the major part of the prime operating system. Therefore, the required maintenance skills are hardly different from those required to maintain the operational equipment. Additional maintenance hours typically will be required to counter the possibly increased number of failures, even though the increase may be small in most cases.

A second logistics support requirement will be for additional spare parts to support the ET subsystem, as well as additional parts to counter the possible greater number of failures of the prime item system. It may also be necessary to make some portions of the prime item system more robust than would be necessary if the system were not to be used for ET. Increases in component strength and durability to counteract the increased usage imposed by training may be required.

T&E activities will need to confirm that ET logistics decisions have identified and allowed for all significant logistical implications.

Cost and Training Effectiveness Analysis (CTEA). An end item system with an ET subsystem may have a higher acquisition cost and, perhaps, a higher operatio cost than it would have without the ET subsystem. However, caref alyses which sharply define the role of ET in the total training syste, and ET designs that fulfill the defined role(s), may show training systems including ET are more cost-effective when compared to alternative total training system configurations. ET will, in most cases, be a marginal cost shared with other software development activities. As such, the specific additional cost of ET may be very low.

Design Impact Questions

Once ET has been selected, after considering these tradeoffs, three T&E questions relating to the impact of ET on operational system design will also require attention:

1. Is it more cost effective to have the ET system built into the operating system than to install it for training and then dismount and store it between training uses? Volume 5 of this series provides guidance to the process of making this determination.

2. Has sufficient computer capacity, over and above that required to meet initial operational mission requirements, been provided to permit the storage, processing, and display of intended ET courseware and simulation data? This particular question is uniquely significant since decisions which set the size of the computing capacity of a system often are made early in the design process. Once made, these sizing determinations are extremely difficult to modify due to space, weight, power, and cost considerations.

3. Does the operating software for the prime system provide access to the operating system or executive software, applications programs, and databases, as appropriate, to allow interactive ET software support? These software "hooks" are essential to the process of generating effective ET programs. This fact is frequently overlooked in the decision process of generating and refining the prime item operating system software.

As with other T&E questions, these three questions should be answered iteratively as the CE process is conducted. Early iterations can disclose the appropriateness of the analyses designed to support answering these questions. Later T&E iterations will establish the actual capability and effectiveness of the resulting system in the form of both system and human performance.

Issue Number 2: T&E for Sustainment Training

ET can be applied to all types of training. Some very common applications of military training are initial skills acquisition, sustainment of skill levels, skill-level progression training, and replacement training during unit rest and reconstitution in wartime. ET has potential application to all of these areas, but it is especially suited to sustainment and other unit training applications because ET is usually located with the fielded systems, in units.

If ET is to be a delivered part of the prime system, then it should be validated. However, there are major differences between T&E designed for sustainment and other unit training versus initial skills acquisition training (that usually takes place in the institution). Evaluation of acquisition training is the basis for most current T&E emphasis and is not dealt with here. This subsection deals with how to accomplish T&E for sustainment and other unit training.

First, the ET which is to be evaluated must truly be the ET intended for sustainment purposes. Once it has been decided that ET will be used for sustainment training, it is important to make a distinction between the content of ET intended for naive trainees (e.g., skills acquisition training) and the content of ET intended for already trained personnel who are being sustained. This distinction is not always clear to the system developers.

Next, there should be a plan for the investigation. A possible experimental design for the evaluation of ET sustainment training capability is shown in Table 1.

Table 1

An Experimental Design for Comparing the Effects of Sustainment Training vs. No Sustainment Training

	Acquisition Training	Test 1	Delay	Test 2	Sustainment Training	Test 3
Group 1	X	X	X	X	X	X
Group 2	X	X	X	X	Delay	X

This design includes several features to evaluate a number of aspects of sustainment training, to give a complete understanding of what has occurred. There is a possibility that not every part of this design can be applied in every test situation, for reasons of resource availability. This design can and should be used as early as is feasible in the ET development program as an EUT&E, conducted in-plant at the contractor's facilities (in-plant testing is discussed in greater detail under issue number 3). Note that many small evaluations of elements of training could be conducted, using this design, instead of a larger and resource-intensive evaluation of large amounts of training.

First, the design uses two groups of trainees for evaluation. Both groups are given acquisition training through whatever means are appropriate. Acquisition training is followed by a performance test (Test 1). This test establishes the level of performance for each group following acquisition training. Next, both groups undergo a delay period during which they do not practice or have anything to do with the new equipment. This delay is important, because it is what makes the sustainment necessary. If the soldiers were using the equipment regularly there might be little or no reason to need sustainment training. However, the usual real-world situation is that soldiers get little time actually using their equipment as they would under wartime conditions. A reasonable period of delay is from two weeks to two months, depending on the anticipated rate of decay of skills to be

trained or sustained for a system. The sustainment evaluation period begins with a second test (Test 2) of both groups, to establish their performance levels just prior to sustainment training. Group 1 then receives ET sustainment training; Group 2 experiences no training or interactions with the equipment. Then, both groups are tested a third time (Test 3).

To better understand the reasons behind each of these tests, this paragraph describes the information provided by each test. The difference in scores between Test 1 and Test 2 shows the decrement in performance (after acquisition) due to lack of practice. The difference in scores between Test 2 and Test 3 for Group 2 shows how much relearning goes on just by experiencing the test but with no other training. The difference between Test 2 and Test 3 for Group 1 shows the improvement due to both the test experience and sustainment training. The increased improvement of Group 1 over Group 2 (from Test 2 to Test 3) is the increment attributable to sustainment training alone.

There are several implications of this approach to the support activities that must take place:

1. An effective acquisition training program must exist to deliver initial training.

2. The sustainment training program must be developed enough to permit evaluation of its training ability.

3. Soldiers must be available at three separate times, once to receive acquisition training, again and to receive sustainment training (or simply performance evaluation for the control group), and again to be retested. These must be the same soldiers.

4. The trainees must be equivalent to those who will receive sustainment training under real conditions.

5. Sufficient soldiers must be available for each group. Ideally, the same number of soldiers should be in each group. If a compromise must be made, reduce the number in Group 2.

This discussion focused only on sustainment training intended to maintain the proficiency of soldiers at or slightly above that which they achieve following acquisition training. The development of higher levels of ability ("expert-level" training) requires further evaluation. Expert training evaluation would require training soldiers to a stable level of good performance, followed by application of the expert training program and further measurement.

Issue Number 3: Performance Testing

Performance testing is defined as evaluation of the ET product as it is developed by performing actual training tests with an appropriate trainee sample and breadboard, brassboard, or prototype ET subsystems. Testing sustainment training, Issue Number 2, is one subset of performance testing. In most cases, the ET component test article will be in the form of preliminary or experimental configurations of hardware and software developed at the in-plant location. This implies that performance testing will most often be implemented as in-plant testing throughout the evolutionary stages of development, as a part of Technical Test (TT) and EUT&E.

In-Plant Testing

In-plant testing of training capabilities, in the sense of formative and summative evaluations of training effectiveness during prime system development, is not officially called for in any of the DoD Directives, Standards, Army Regulations or Pamphlets. Formative evaluation involves review and testing of individual pieces of ET hardware and software or ET courseware during the development phases. Summative evaluation is done when all the pieces can be combined into an operating whole, and assesses the levels of skill or performance resulting from training. Because of the unique nature of the design of ET, testing must occur in the early phases of development and, therefore, must be done "in-plant" as the prime system and the ET component evolve. Such testing must also be done in coordination with the development and testing of the end item equipment, as described for CE, to assure that deficiencies can be remedied while preserving the operating objectives of both the prime system and ET.

Two kinds of testing are required: 1) testing to confirm that the ET component operates as expected (do the hardware and software and the instructional features function?), and 2) to confirm that training presented via the ET subsystem (including courseware) teaches appropriately (does the ET subsystem meet learning objectives?). Following the CE concept, the "does it function" question pertaining to ET subsystem components can be examined on an individual or subset basis as designs are transformed to brassboard or prototype fabrication. To examine whether ET-based training teaches, an operating ET subsystem or operating element of the complete ET subsystem is necessary, along with representative courseware which would be presented on or by that element.

Results from these two types of tests should influence both continuing ET component design and, in all probability, continuing prime item system design, as well. In addition, results from the test of whether ET teaches should continue to structure the specific nature and content of the developing courseware.

Appropriate ET test and evaluation, from the emergence of the earliest ET design through system fielding, requires significant amounts of T&E time and resources. To do ET T&E will require the soldier interface, or functioning portions of it, plus the appropriate prime system software drivers, databases, and simulation displays, as well as ET-implementing software and (if applicable) ET courseware and ET-specific hardware. In many, if not most instances, required T&E periods will exceed the amount of time that can be reasonably made available on engineering breadboards, brassboards, or prototypes. This will be especially true for the assessment of courseware, since studies with actual training exercises and multiple students (subjects) will be necessary. Such testing will not only require access to an appropriate facility (a working ET interface), but will also necessitate an ongoing program of training material development.

It is strongly recommended that the Request for Proposals (RFP) for every prime item system for which ET is a principal consideration require an ET testbed. This testbed, or series of testbeds, will permit the continuous formative and summative evaluation of ET as the system evolves, without interfering with the ongoing engineering design, testing, and fabrication of the prime system. There may be specific instances where ET testing can be effectively done using testbeds designed for other purposes. As previously stated, the results from such testing, done in parallel with engineering development, will provide direct input not only to the design of the ET subsystem, but to the overall design of the prime item system, and will allow insightful and cost effective tradeoffs between subsystem designs to be made and further evaluated.

Testable ET Segments

Successful ET development depends upon the following major activities:

1. Establishing a timely working relationship between training developers and other members of the prime item system design team.

2. Defining the role of effective ET in both the total training system and in the context of job performance (i.e., identifying which skills and knowledges will be a part of ET for individuals, crews, or netted exercises).

   (These first two activities are not traditional T&E functions. However, each is essential to effective integration of ET with the prime equipment. These activities are discussed more fully in Appendix B.)

3. Integrating requirements of the ET component design with those for the prime item system (i.e., computer capacity, soldier-machine interface, software "hooks," etc.).

4. Configuring the ET component interface so that interactive training can occur.

5. Developing courseware and associated software to achieve ET component goals.

Items 3 - 5 should be identified and cited as testable items in the RFP and contract. Appropriate planning will permit the individual testing of these products as a part of planned CE and will foster ET materials development in testable segments. When specified as contract deliverables (perhaps as Data Items under a training contract line item, supporting specific performance requirements included in the system specification document or Statement of Work), plans, progress, and T&E results will be reportable as part of the In-Process Reviews (IPRs). This type of developmental exposure facilitates coordination and the resolution of trade-off and design differences.

T&E Courseware Which Supports Operational Testing

Once an operational interface is available in the form of an ET testbed, many of the tests which will be conducted will require actual or representative courseware. As discussed, this courseware will permit the assessment of the functionality of the ET hardware and operating software, and of the effectiveness of the intended courseware configuration (Do trainees learn and retain the appropriate skills and knowledges?). Often, implementing these tests will require developing specialized courseware designed specifically to activate a particular ET component or function in a selected way. In other instances, courseware will be needed to assess the viability of a particular approach to training, or the application of a specific ET medium (e.g., simulation or stimulation involving prime item SSI displays). For example, testing may require a unique piece of courseware to structure a test of whether the timing of a specific display generation fits a particular practice scenario or situation. In both instances, the courseware may not have direct application to some ultimate set of user training requirements (since, for one thing, these requirements may not be completely known at the stage of development when such testing must be initiated). Often, the courseware developed to support such testing may not be useful beyond its T&E function. However, if the courseware developers stay in close contact with the TIWG and combat developers, it will be possible in many instances to configure test courseware to also provide direct training support to Initial User Test and Evaluation (IUT&E) and Follow-on Test and Evaluation (FOT&E), even though that courseware may not be what is ultimately fielded.

APPENDIX A

AMC/TRADOC PAMPHLET 70-2, MATERIEL ACQUISITION HANDBOOK (1987)

CHAPTER 13, TEST AND EVALUATION

Chapter Guide

This chapter describes test and evaluation (T&E) procedures in terms of the Army Streamlined Acquisition Process (ASAP). Information comparing activities in the DOD and ASAP models is provided in Chapter 1 and Appendix j.

Chapter Proponent Offices

AMC: AMCQA-ST

TRADOC: ATCD-TP

References

DOD: DODD 5000.3-M-1

DA:
AR 15-18
AR 70-1
AR 70-10
AR 71-3
AR 71-9
AR 702-3
AR 702-9
PAM 70-21
PAM 71-3

TRADOC:
PAM 71-13
PAM 71-15

Objectives

T&E is conducted to assist the decisionmakers in reducing and assessing acquisition risks by:

a. Verifying attainment of technical performance specifications, objectives, and supportability to include logistics supportability.

b. Verifying materiel defect.

c. Assessing operational effectiveness, operational suitability, and readiness.

d. Determining training requirements, compatibility, and interoperability among Army systems and with the North Atlantic Treaty Organization and other Services.

Overview/Responsibilities

T&E are integral facets of the materiel acquisition process. T&E ultimately provides the data to answer the basic concerns of (1) will the systems perform like it's supposed to, (2) can the soldier use it, and (3) can we afford it?

Army policy calls for integrated testing where feasible and using all available data (e.g., contractor, other Services, and foreign) for evaluation. This policy is aimed directly at reducing testing by using all available data for planning and evaluation. The two basic categories of test occurring throughout the materiel acquisition process described in AR 70-10 are Technical Test (TT) and User Test (UT). TT determines the engineering, safety, and manufacturing aspects of the equipment. UT determines the troop acceptability aspects, operational effectiveness, and suitability in the tactical environment. The technical tester is TECOM; the technical independent evaluator (TIE) is either TECOM or AMSAA, as designated by HQ AMC. The operational tester and evaluator is either TRADOC or the Operational Test and Evaluation Agency (OTEA), designated by ODCSOPS. TRADOC also performs UT and experimentation.

The acquisition process initial actions occur when the user requirement begins formulation through the MAA/BDP process at TRADOC. The Mission Area Analysis Test Advisory Group (MAATAG) identifies and plans early TRADOC experimentation and test using standard and surrogate equipment. These experiments, coupled with the materiel developer (MATDEV) technology experimentation/demonstration, provide the necessary information for program formulation at the Technology Integration Steering Committee (TISC) I proceedings.

If the alternative of developing a weapon system to satisfy the user's deficiency is selected, TISC I triggers a system development program start. At this point, the acquisition team representatives meet and form the TRADOC chaired Special/Joint Working Group (SWG/JWG). The MATDEV assumes responsibility for materiel system in about 60 days from the first meeting of the SWG. TRADOC continues with the responsibility of doctrine, tactics, organization, training, logistics, etc.

Critical evaluation issues are prepared by the combat developer (CBTDEV) in coordination with the MATDEV, TIE, and operational independent evaluator through the SWG/JWG. These issues accompany the O&O Plan until it's approved. Critical issues will be updated and approved with ROC development. The CBTDEV and operational evaluator supporting issues are reviewed by the TMEC.

The TIE and developer's supporting issues are reviewed/approved by the AMC Materiel Acquisition Review Board (MARB). The format for submission of critical evaluation issues and criteria is as shown:

a. ISSUE: Questions applicable to evaluating operational effectiveness and suitability of a system.

b. SCOPE: Conditions applicable to the issue.

c. CRITERIA: Quantitative measures of the system's operational effectiveness and suitability used to judge whether the system satisfies the issue.

d. RATIONALE: Justification for the criteria.

It is the responsibility of the acquisition team to integrate/combine tests for the most efficient and cost-effective test program. This is done through the Test Integration Work Group (TIWG).

A TIWG is established by MATDEV based upon the draft O&O Plan. The TIWG is composed of the MATDEV (chair), CBTDEV, technical tester, TIE, operational tester, operational independent evaluator, logistician, and trainer. Other representatives may be added, as necessary.

NOTE

Initially the TIWG membership is essentially the same as the SWG/JWG and are usually the same faces.

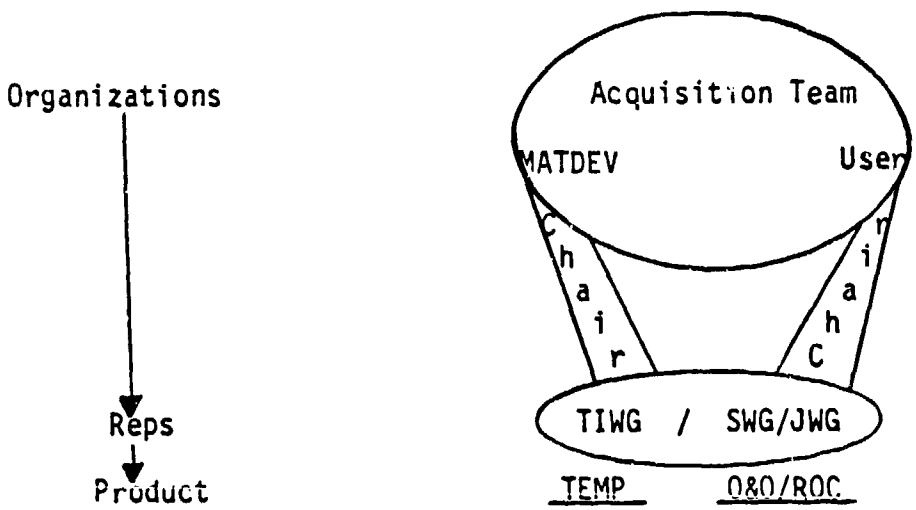


FIGURE I

The TIWG develops a Test and Evaluation Master Plan (TEMP) that covers all T&E through the production/deployment phase. In short, it provides a road map of T&E through the acquisition process for each system/item. Because of the update procedures, it is a "living" document. TEMP procedures and formats are contained in AR 70-1 and DA Pamphlet 70-21. By virtue of the TEMP format, the TIWG is forced to use a systematic approach that identifies what data is needed (Master Evaluation Plan (MEP)) to satisfy the issues before planning tests to produce data. Information contained in the TEMP will be used as structuring contractual documentation. The TEMP is submitted as a package with the AS for approval by the appropriate level MADP before entering Proof of Principle.

For the responsible MATDEV, the TEMP provides a documented log of plans, coordinations, and results. For all others, it provides a documented agreement of what is planned and has been accomplished.

Since the TEMP is a living document, an ingredient for feedback is necessary. This ingredient is the common T&E database. This mechanism will permit the acquisition team to "continuously evaluate/analyze functionally" system progress. Systematic review of the information in the common T&E database by the acquisition team exposes problems/issues for early solutions at the working level, and encourages efficient system development. Other considerations during test planning are: T&E Managers, Test Technology/Facilities, Test Funding, and Continuous Evaluation (CE).

Test and Evaluation Managers

Each AMC MSC has designated a test manager to manage the T&E functional area within the command. The test managers coordinate directly with HQ AMC, TECOM, and other test managers and assist test planners as a matrix function.

Test Technology/Facilities

With the advanced technology that is being applied to new weapon systems, the need for appropriate test technology to support testing of these systems is recognized. TECOM has established a central coordination office to ensure that all AMC/Army testers are aware of new test technology being developed/built. The central coordinator assists in eliminating duplicate development efforts and maximizing the use of existing test facilities by sharing information on test facilities. TECOM Technology Office - AMSTE-TC, APG, MD.

Test Funding

MATDEVs are responsible for programing funds for all system test costs IAW AR 37-100, AR 70-10, AR 71-3, and AMC Supplement to AR 37-100. Users are responsible for programing funds for all innovative, CEP, FDTE, and OTs using a system IAW AR 71-3. NOTE: MATDEV funds materiel portion of OT.

Continuous Evaluation (CE)

CE represents a thrust to assure the continuous flow of updated information regarding system status including planning, testing, data compilation, analysis, evaluation, and conclusions, and is available to all members of the acquisition team plus decisionmakers from the initial O&O Plan through deployment and assessment of field performance. CE is performed by each member of the acquisition team. A major objective is for the members to be active in surfacing critical problems at the earliest opportunity so that they may be addressed and resolved before they impact important decisions. This helps eliminate last minute surprises.

CE essentially ensures that:

a. Testers and independent evaluators are exposed to the system early so that realistic T&E requirements may be planned and developed.

b. Requirements and specifications that drive T&E considerations are made available to the testers and evaluators to stabilize the test program.

c. Contractor and Government test data as well as data from other sources are made available to be used in the continuous evaluation process.

d. Optimum testing is scheduled to preclude duplication in the interests of reducing testing for the overall test program.

The evaluators assess and evaluate the technical performance, operational effectiveness, and operational suitability of a system throughout the entire materiel life cycle. The results of each of these evaluations are provided by each evaluator to the Acquisition Executives. Within AMC, TECOM and AMSAA provide TIEs; the MATDEV (PM, Team Manager, et al.) provides a developer's evaluation. The operational independent evaluators are either OTEA or TRADOC. TECOM is the repository for all T&E data and the database is located in APG MD The test community feeds the database with test data per the 1986 MOU between TRADOC, OTEA, and AMC.

Time Constraints

Once a system has been identified to be developed, the acquisition team representatives are designated. The O&O Plan, AS, and TEMP are developed. Note the reliability plan must be developed before the TEMP can be finalized as a coordinated draft. Also, the TEMP must be approved by the appropriate level MADP before any testing occurs in the Proof of Principle Phase. The goal is to provide test results and evaluation analyses on production items for Milestone III. Approved test waivers are covered in AR 70-10.

Process Outline

Detailed procedures for T&E are described on the following pages in the form of descriptive paragraphs keyed to corresponding actions on the charts. The format displays specific activities in each phase of the materiel life cycle conducted by the CBTDEV, MATDEV, evaluators, testers, and industry. It should be recognized that the charts depict the product (document, activity, etc.) under responsible activity. Activities are pictorally ordered to provide a general time sequence.

1. MAA/BDP are the initial materiel acquisition process actions.

2. Technology experimentation/demonstration occurs during early technology feasibility research.

3. User Experimentation. . TRADOC user testers perform user experimentation (CEP, FDTE, or innovative testing) as outlined by the MAATAG, CBTDEV, and training developer. These early and continual user test and experimentation efforts serve to--solidify the materiel need and support O&O Plan preparation, support development of critical evaluation issues and criteria, and foster initiation of doctrine, tactics, organization, and training packages. Experimentation planning and reporting guidance is contained in AR 71-9.

4. MAATAG. The MAATAG functions as a subcommittee of the MAA. It identifies user experimentation requirements to support the MAA and operational requirements definition process. Also, the MAATAG defines the experiment issues and provides initial planning guidance.

5. MAMP. See chapter 2.

6. Safety Release. A safety release, if necessary, will be provided by TECOM as a customer service IAW AR 350-16.

7. The Technology Integration Steering Committee (TISC) pairs technological opportunities with emerging requirements. It includes joint (MATDEV/CBTDEV) representation and meets semi-annually. TISC-I matches technological opportunities with Army thrusts and emerging mission needs. It triggers the preparation of an O&O Plan or JMSNS. It also directs technology maturation actions needed for subsequent steps. TISC findings support MAMP and LRRDAP prioritization of resources, as well as MATDEV/CBTDEV MARB deliberations/In-Process Reviews (IPRs).

8. The O&O Plan (or JMSNS, if required) is the program (system) initiation document and is approved before TISC II review.

9. Critical evaluation issues and criteria will be approved by the Materiel Acquisition Decision Process (MADP) Review and included in the TEMP. These issues lead to the test issues through the Independent Evaluation Plan (IEP) process.

10. The TIWG formulates the first broad scope TEMP which includes a reliability plan (AR 702-3). This group ensures the testing program outlined by the TEMP is coordinated in support of the AS. All testing will be identified in the TEMP, to include testing of product improvements. The TEMP is a "living" document. Between milestones, this coordinated TEMP is considered approved by TIWG consensus unless the MADP decision authority (who is notified in writing of changes) disapproves. Each TIWG representative is responsible for his command's concurrence. The overall TEMP requires concurrence prior to milestones by all TIWG membership. It is forwarded to the MADP review body for approval as part of the supporting documentation. Instructions for the TEMP and its preparation are in AR 70-10 and DA Pam 70-21.

11. CE starts after TISC I and continues throughout the process. The T&E database used for CE will be fed by the TIWG membership. The gradient on the chart indicates the initial data input to the database.

12. Experimentation Reports. These are the reports for all previous user and technical experimentation that will be encompassed in the formulation of the system. This data will be part of the initial TEMP data reviewed by the TISC.

13. Outline Test Plans (OTP)/Resume Sheets are prepared IAW TRADOC Pam 71-15.

NOTE

The OTP is updated every 6 months for Test Schedule and Review Committee (TSARC) for FDTE resume sheets are for CEP and are approved by TRADOC with changes worked out between proponent and tester. The OTP is a resource document which usually is prepared for the TSARC (AR 15-38) by the operational tester. OTPs will be prepared by the MATDEV when additional testing resources (normally FORSCOM support) are required. It contains a listing of the necessary resources and administrative information required for support of a test. The OTP also contains the critical test issues, test conditions, and scope. Additionally, the OT OTP will address tactical context.

14. The TIE and operational independent evaluator each prepare an Independent Evaluation Report (IER) for all aspects of evaluation responsibilities relative to the system including market investigation. The IEP details the independent evaluator's actions for the evaluation of the system. It is periodically updated, at least annually, reflecting materiel and program changes. The operational independent evaluator has the responsibility for preparation of the Master Evaluation Plan (MEP). The MEP consolidates the technical and operational independent evaluation plans with the materiel developer's (MSC/PM) detailed plans for evaluation of the system. The evaluation plans take into account all available data to preclude unnecessary testing while assuring that evaluation objectives are achieved. The MEP will identify each issue for evaluation and the methodology to be used. The MEP will specify the procedures for exchange of evaluation information, if necessary. The MEP requires concurrence by member agencies of the TIWG. The MEP will be an annex to the TEMP. Instructions for its preparation are in DA Pam 70-21. The Test Design Plan (TDP) is a formal document which supports the TEMP and may be provided as an annex to the TEMP. TDPs are derived from the IEP and are prepared by the TIE and the operational tester. The TDP is responsive to the technical and operational issues developed by each evaluator. It includes a complete test design, description of required tests, the conditions under which the system is to be tested, a statement of test criteria, and measures and plans for data collection for the TDP.

15. System Support Package (SSP). The list of items in the SSP (plus shortages) to test is developed by the MATDEV. SSP for each test is developed IAW DA Pam 71-3 and refined before each readiness review and test.

16. Test Support Package (TSP). TRADOC combat developers and training developers begin preparation of the following TSP in preparation for experimentation during the Proof of Principle Phase and OT during the Development Proveout Phase:

    a. Doctrinal and Organizational Test Support Package.

    b. Threat Support Package.

    c. Training Test Support Package.

    These packages are refined as the program progresses IAW DA Pam 71-3.

17. TISC II reviews the "match" and maturity of TISC I solutions for suitability to advance to Proof of Principle. The MARB follows.

18. MARB. See MADP chapter 15.

19. A "Star Review" ("16 Star Review" for major programs) is held to establish top-down consensus on basic program direction at onset of the Proof of Principle Phase. The principles are determined by the level of the MADP decision authority (e.g., major programs - VCSA, USofA, AMCCG, and TRADOC CG). The review verifies and lends senior leadership impetus to the basic program parameters and course of action outlined for this acquisition phase. It reviews the TEMP, AS, and O&O Plan as a minimum.

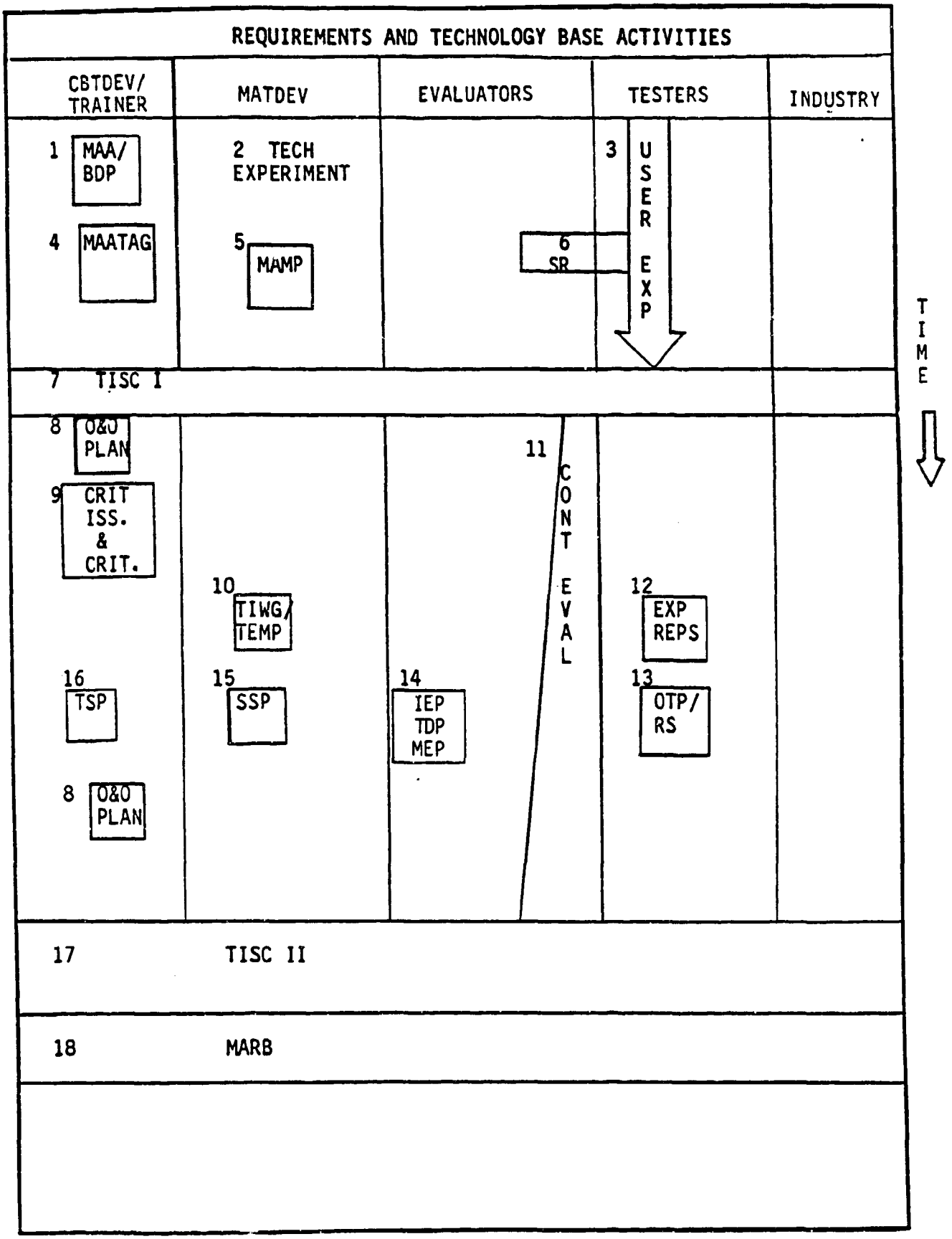
20. Update TEMP.

21. Update IEP/TDP/MEP.

22. ROC is initiated IAW AR 71-9. Issues and criteria are updated, approved, and TEMP so updated. ROC is approved approximately 1 year before Milestone I/II.

23. Technical Test Readiness Review (TTRR) is chaired by the MATDEV with the principle TIWG members in attendance IAW DA Pam 70-21 (similar to Operational Test Readiness Review (OTRR)).

24. User Test Readiness Review (UTRR) conducted by the user tester for user experiments at system level. The UTRR is conducted in the same manner as the OTRR described in the next phase (#42).


REQUIREMENTS AND TECHNOLOGY BASE ACTIVITIES
CBTDEV/ TRAINER
MATDEV
EVALUATORS
TESTERS
INDUSTRY
1 MAA/ BDP
2 TECH EXPERIMENT
3 USER EXP
4 MAATAG
5 MAMP
6 SR
TIME
7 TISC I
8 O&O PLAN
9 CRIT ISS. & CRIT.
10 TIWG/ TEMP
11 CONT EVAL
12 EXP REPS
13 OTP/ RS
14 IEP TDP MEP
15 SSP
16 TSP
8 O&O PLAN
17 TISC II
18 MARB

25. Contractor begins fabrication of prototype/surrogate/ brassboard hardware and conducts contract required tests.

26. T&E is conducted in this phase as integrated by the TIWG process in the TEMP document. It includes separate, combined, and concurrent user experimentation and technical testing. T&E conducted during this phase supports the hardware/software design through an approach which will be performed at the component, subsystem, and system level; identifies the preferred technical approach, including the identification of technical risks and feasible solutions; examines the operational aspects of the selected alternative technical approaches, estimates the potential operational effectiveness and suitability of candidate systems; supports the product improvement proposal (PIP) process; reduces design risks; establishes contractual compliance including component qualification; provides data for required readiness for test reviews; and evaluates technical and operational issues.

27. A Safety Release is processed IAW AR 385-16 in preparation for UT.

28. Test Incident Report (TIR) Summary. The TIR Summary is prepared by the MATDEV for the correct action review. All user and technical test TIRs are included.

29. The Test Report (TR) is a formal document of record which reports the data and information obtained from the conduct of the test and describes the conditions which actually prevailed during test execution and data collection. Included in the TR is an audit trail of deviations from the TDP. TRs are prepared, approved, and published by the technical and operational testers.

30. A corrective action review process conducted by the MATDEV is in the formal process to assess and improve reliability, availability, and maintainability (RAM) performance (See AR 70-10). Each activity, which has been assigned responsibility for corrective action IAW AR 702-3 will report on the actions that have been taken to correct each failure mode identified during tests. Adequacy of failure analysis, appropriateness of corrective action, demonstration of corrective action by tests, verification of future implementation, and evaluation of effectiveness of the corrective action will be assessed by the CBTDEV, MATDEV, the technical and operational testers, and evaluators. An audit trail of changes will be established and reported to the design authority. In addition, the MATDEV (MSCs/PMs) will use the RAM-scored data in the development of reliability and maintainability growth models and assess the impact of meeting the technical and operational thresholds.

31. The IER is an independent evaluation of the system based on test data, test reports, studies, and other appropriate sources. IERs are prepared, approved, and published by the technical and operational independent evaluators at key milestone events. Under the CE concept, the independent evaluators will periodically update their evaluation of the system. The IER, a formal document of record, contains an assessment of the issues contained in the IEP and other issues as appropriate; the independent evaluator's conclusions; evaluation of test issues; the evaluator's position on the future capability of the system to fulfill the approved requirements; and identifies program constraints and their impact on the evaluation. The IERs are provided to the MADP review, as appropriate; the independent evaluator's conclusions; evaluation of test issues; the evaluator's position on the future capability of the system to fulfill the approved requirements; and identifies program constraints and their impact on the evaluation. The IERs are provided to the MADP review body. IERs are normally briefed by the TIE directly to the pre-ASARC or IPR; and by the operational independent evaluator directly to the ASARC, or IPR.

32. Update TEMP for next phase.

33. Update IEP/TDP/MEP for next phase.

34. Update OTP for FDTE and IOT&E for next phase.

35. Milestone I/II Review.

36. Update TEMP.

37. Update IEP/TDP/MEP.

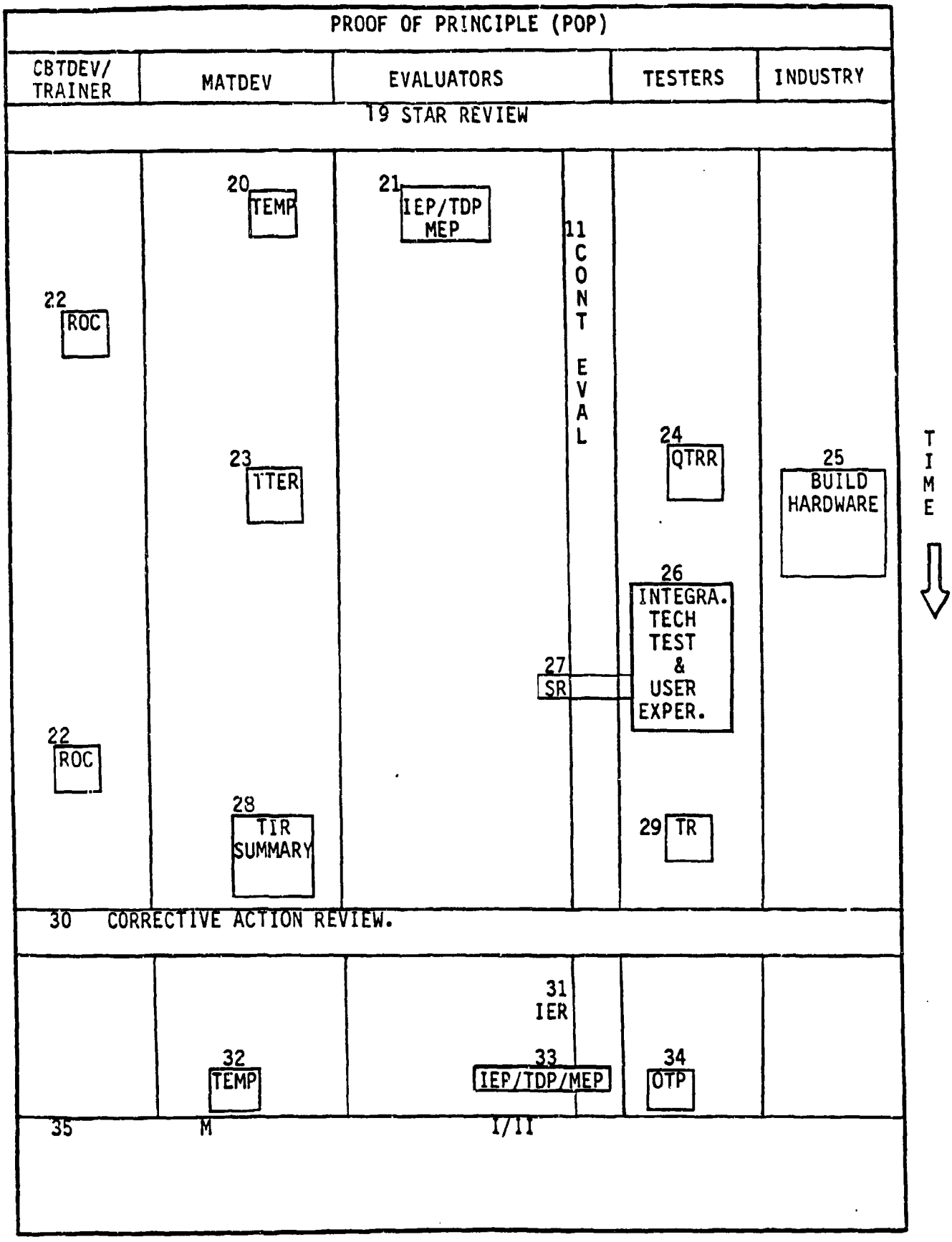
38. Contractor builds hardware/software system, conducts contractually required tests.

39. Instructor and Key Personnel (I&KP) is provided by the MATDEV based on the training requirements developed by TRADOC for the testers.

40. Operational Test Readiness Statements (OTRS) are provided by the trainer, CBTDEV, and MATDEV.

41. Same as item 23.

42. OTRR is a review to identify problems which may impact the conduct of an OT&E. An OTRR is conducted to determine changes required in planning, resources, or testing necessary to proceed with a specific OT. OTRR participants include the operational tester (chair), independent evaluator, MATDEV, user representative,


PROOF OF PRINCIPLE (POP)
CBTDEV/ TRAINER
MATDEV
EVALUATORS
TESTERS
INDUSTRY
19 STAR REVIEW
20 TEMP
21 IEP/TDP MEP
11 CONT EVAL
22 ROC
23 TTER
24 QTRR
25 BUILD HARDWARE
TIME
26 INTEGRA. TECH TEST & USER EXPER.
27 SR
22 ROC
28 TIR SUMMARY
29 TR
30 CORRECTIVE ACTION REVIEW.
31 IER
32 TEMP
33 IEP/TDP/MEP
34 OTP
35
M
I/II

logistician, HQDA staff elements, and others as necessary. The OTRR examines the OTRS and the safety release prior to the start of the test and may include review of initial or pilot tests. The OTRR is mandatory for major and DAP systems with the results reported to ASARC principals. An OTRR is conducted for other systems, as determined necessary by the operational tester.

43. The integrated testing in this phase includes FDTE, IO&E, DT&E, and qualification testing. T&E conducted during this phase matures development prototype hardware/software; provides a valid estimate of the system's operational effectiveness and suitability (including performance, survivability, reliability, availability and maintainability, safety, MANPRINT, and logistic supportability); ascertains whether engineering is complete; identifies design problems and ascertains that solutions to these problems are in hand; supports the PIP process; reduces design risks; establishes contractual compliance; validates general and detailed specifications, standards, and drawings for use to procure units of products; provides data for required readiness for test reviews; and evaluates technical and operational issues. Testing includes hard-tool prototypes to resolve OT issues. FDTE conducted in this phase refines and validates tactics, organization, and training before IOT&E.

44. Contractor provides hard-tool prototypes from production line.

45. Update TEMP.

46. Update IEP/TDP/MEP.

47. Update OTP.

48. Same as 29.

49. Same as 31.

50. Update issues.

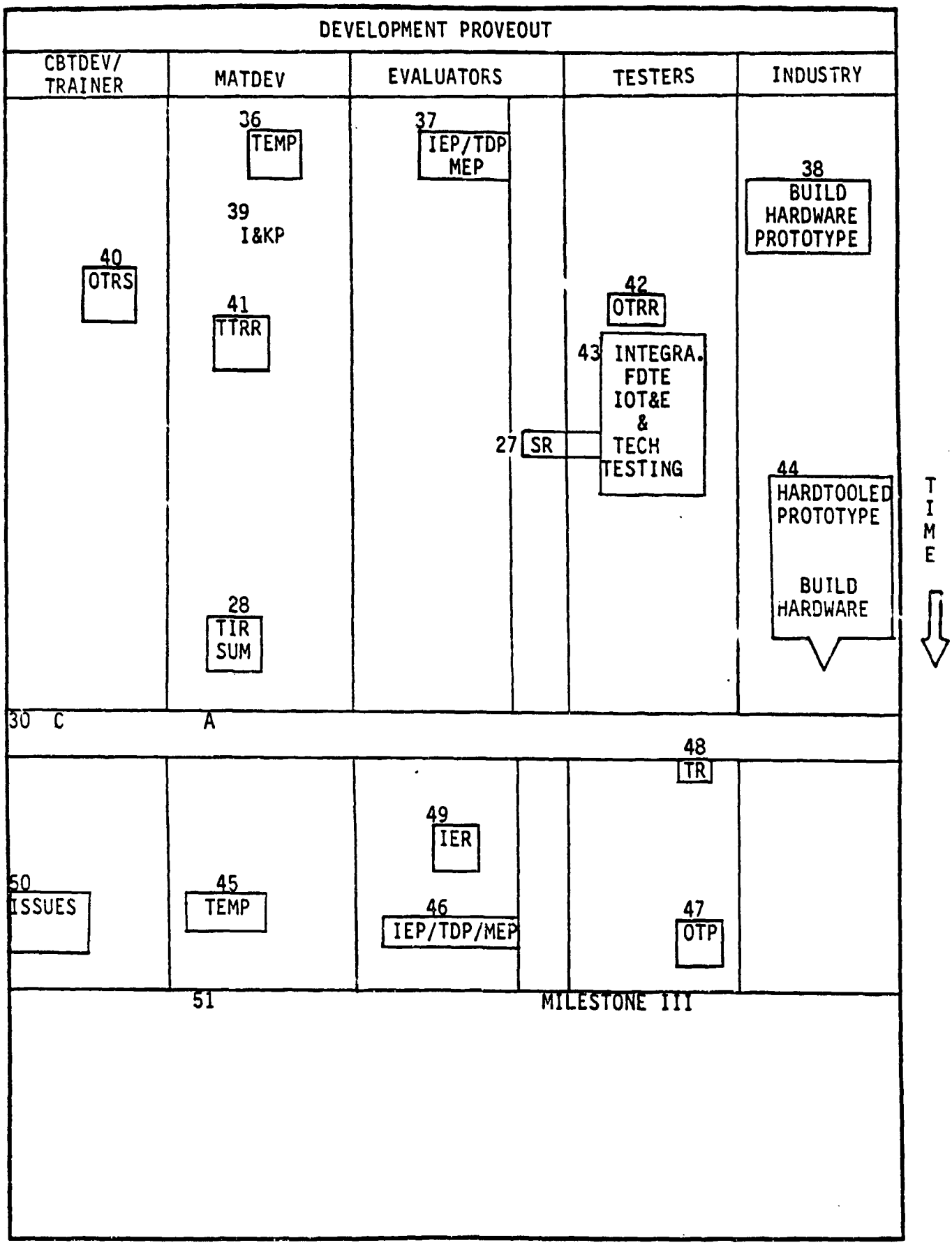
51. Milestone III review.

52. Update TEMP.

53. Update IEP/TDP/MEP.

54. Same as 42.

55. Same as 40.


DEVELOPMENT PROVEOUT
CBTDEV/ TRAINER
MATDEV
EVALUATORS
TESTERS
INDUSTRY
36 TEMP
37 IEP/TDP MEP
38 BUILD HARDWARE PROTOTYPE
39 I&KP
40 OTRS
41 TTRR
42 OTRR
43 INTEGRA. FDTE IOT&E & TECH TESTING
27 SR
44 HARDTOOLED PROTOTYPE
BUILD HARDWARE
TIME
28 TIR SUM
30 C
A
48 TR
49 IER
50 ISSUES
45 TEMP
46 IEP/TDP/MEP
47 OTP
51
MILESTONE III

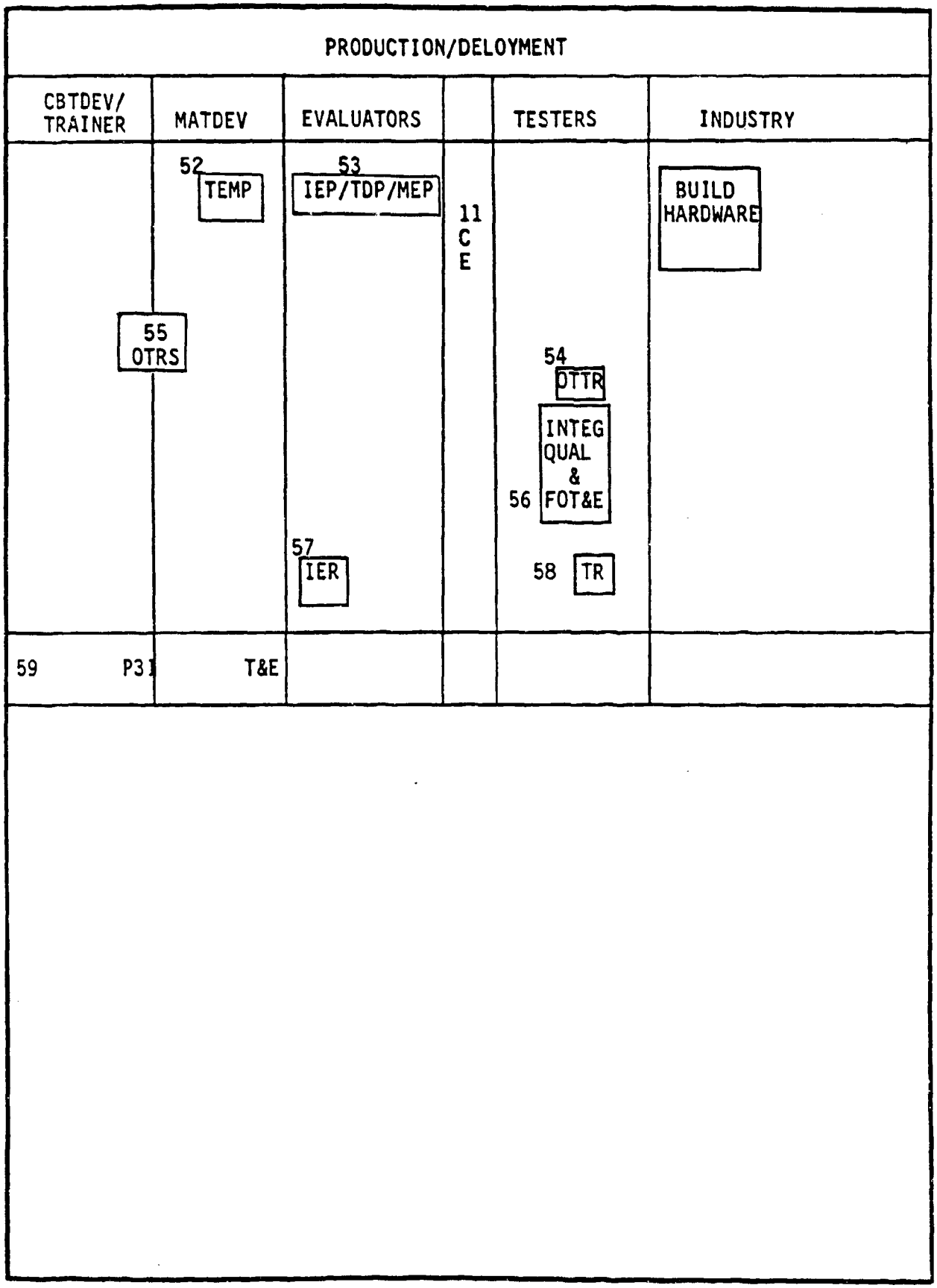
56. If qualification testing was not completed in the Development Proveout Phase, it will be completed in this phase. Sufficient testing should have been completed in the last phase to permit the DOTE to be reported to Congress.

57. Same as 31.

58. Same as 29.

59. Preplanned Product Improvement (P3I) testing. Testing of the first block improvements to the system, based on Proof of Principle and Development Proveout Phase testing, occurs on production items.

This testing is integrated by TIWG and IAW AR 70-21.


PRODUCTION/DELOYMENT
CBTDEV/ TRAINER
MATDEV
EVALUATORS
TESTERS
INDUSTRY
52
TEMP
53
IEP/TDP/MEP
11
C
E
BUILD HARDWARE
55
OTRS
54
OTTR
INTEG QUAL & FOT&E
56
57
IER
58
TR
59
P31
T&E
TIME

APPENDIX B

NON-TRADITIONAL ASSESSMENT OF THE ET DESIGN PROCESS

Early in a system development cycle, testing the process of design is far more critical then testing the products of design. Prime system testing has traditionally examined the functionality of hardware and software against system specifications, with the overall concern of effectively meeting mission requirements. Likewise, training system and training device testing has also focused on the operation of hardware and software, and on the effectiveness of learning stimulated by the system or device. However, constraints on the design process for ET differ in a number of respects from those structuring typical system design efforts. The most important of these constraints is that ET and prime system operational characteristics must be mutually supportive. With ET, whether built-in or hung-on, the design window is limited in time and rigorous in content. There is little opportunity to recover from having designed late or poorly.

The purpose of this Appendix is to call to the attention of contractors and proposal evaluators issues which appear to be critical to a successful ET design program. Limited experience to date with development of ET programs strongly suggests that, while they are not traditional T&E areas, these issues form a reliable litmus test for probable success.

The design of successfully integrated ET is totally dependent upon having instructional systems designers as a part of the overall end item equipment design team, and upon early and iteratively updated embedded training requirements analyses which influence design. Without a multidisciplined design team, and ET-relevant analyses, only luck can produce effective ET. With this level of criticality, it follows that prudent program management should initiate and vigorously pursue an assessment of the organization and process for designing; i.e., "testing" of the design mechanism. Early on then, usually well before Milestone I, the nature of the "tests" should be focused on assuring that training system design, and the development of ET in particular, will be appropriately accommodated by developmental planning, organizing, and manning. Without the intention and commitment to provide the personnel and funding resources needed to attain effective ET, integrated ET design is neither feasible nor practical. As development progresses, the nature of appropriate testing will shift toward the traditional focus of T&E procedures: does it work, and does it meet stated requirements? Two major issues are germane to this non-traditional assessment situation:

Issue Number 1: Integration of Embedded Training With Prime System Design

Performance testing of the ET component generally occurs in conjunction with the operation of the prime system, since the soldier's operational interface is utilized as the training interface. However, at the point in development where there is an operational soldier interface, a great deal of time and system design effort will have been expended, and many design decisions will have been firmed in terms of configuration, hardware and software requirements, etc. This may be too late in the development process to be able to influence system characteristics to enable ET functions to be included in the system.

Under the CE concept, and within the MANPRINT portion of this type of evaluation, the purpose of testing is to account for the effects of expected soldier performance, system effectiveness, and operational availability. System effectiveness, in the case of ET, refers to the effectiveness of the ET components. Experience teaches that this component will not be effective unless ET subsystem designers play a significant and active role along with the prime system designers in establishing operational parameters and realistic performance tradeoffs. Therefore, the ET subsystem must be planned at the same time and in concert with the planning for the operational system. This will require that the ET subsystem designers be an integral part of the design team from the very beginning.

At the time of preparation of initial procurement documentation, critical questions which provide the criteria for evaluation of proposals and subsequent contractor performance include:

1. Is embedded training being considered for principal roles in the proposed total training system?

2. Are instructional technologists (instructional systems designers) a required and assigned part of the design team?

3. Will the prime contractor be selected on the basis of his proposed approach to training design (including ET), as well as on his proposed approach to the operational system development?

4. Is there a design philosophy which will consider tradeoffs between operational and ET features, to maximize the effectiveness of both?

5. Does the planning for continuous evaluation include a specification which assures that ET T&E will be rigorously pursued in parallel with the functional and component continuous evaluation activities for the operational system?

Number 2: Early Identification Embedded Training Requirements

Embedded training can take many forms, depending upon the characteristics of the system, the configuration of the soldier interface, the specific skills and knowledges to be trained, and the "stage" of learning for which the ET subsystem is intended (e.g., sustainment as contrasted to initial acquisition). The process of establishing the specific performance requirements which the ET component will be designed to support is the most critical activity during the design efforts which occur prior to Milestone I/II. This criticality is not different for ET than for other types of training system designs; in all cases accuracy and completeness are crucial to the design effort. However, in traditional training system development, the training materials which are developed to meet operational needs can be modified and augmented at a later date in the development cycle without jeopardizing the effectiveness of the system itself, or significantly lengthening the duration of training development. With an ET component, once appropriate tradeoffs and determinations have been established to permit the design of an ET interface and delivery system, the degrees of freedom to modify that design become severely restricted as the operational system design is solidified.

Because it is essential to "do it right and do it early," it is important to assure that the analyses needed to establish appropriate job relevance are both timely and comprehensive. Guideline Volume 4 entitled, "Identifying ET Requirements," establishes the specific procedures appropriate for generating and compiling ET requirements. Some oversight process must confirm that the required analyses are indeed being accomplished, and that the data are sufficiently detailed and accurate so that firm design decisions can be made. This process is probably not within the traditional scope of T&E. Nevertheless, training development members of or advisors to the TIWG must be aware of the importance of this issue and its component sub-issues. Overlooking any of these issues could prove disastrous from the point of view of developing well-integrated and effective ET. If for no other reason, training-oriented testers and TIWG members should be aware of these oversight needs, and attempt to coordinate the oversight process with MANPRINT surveillance of the developing system. Indeed, it may be appropriate to include these issues and specific training issues in the process of developing the System MANPRINT Management Plan (SMMP) for systems anticipated to include ET.

As with Issue Number 1 (see Page 21), the substance of this issue has to do with the existence and the effectiveness of an analytic process which is essential to produce the data needed for ET design decisions. Oversight needs for this issue deal with the completeness and accuracy of the design process, since it will be too early to evaluate the ET design itself. Specific considerations in the oversight process include gathering data to answer the following questions:

1. Are there iterative applications of the guideline procedures specified in Volume 4 "Identifying ET Requirements" beginning in the Requirements and Technological Base Phase in the Army Streamlined Acquisition Process (ASAP) or in the Concept Exploration Phase of the LCSMM? Application of these procedures should result in the identification of operational system missions, phases, jobs and functions, or tasks. In addition, this process should identify significant conditions of performance which will influence operations and maintenance training requirements.

2. Is there integration of the preliminary ET requirements into the design of a <u>total</u> training system concept for the operational system? As has been emphasized throughout these guidelines, ET can be but one component of the total training system for any prime operational system. In order that ET maximally support the total set of system training requirements, it can only be designed in concert with the total training system. At this point in the developmental process, the existence of an overall design effort for the complete training system must be assessed in order to provide many of the criteria for judging the configuration and instructional content of the ET component.

3. Are there iterative applications of the ET requirements (ETR) identification procedures during the Proof of Principle Phase of ASAP (or late in the Concept Exploration phase or early in the Demonstration and Validation Phase of the LCSMM)? These analyses must focus on the identification of specific behavioral performance objectives and on updating and expanding the task identification accomplished earlier. Assessment of this application will essentially consist of confirming that the systems approach to training (SAT) task analysis procedures are indeed being accomplished and are resulting in a total task analytic database.

4. Are task analytic data derived from the ETR analyses being integrated with the design of the total training system, including stand-alone training devices and schoolhouse training, as well as ET? For any particular prime system design effort, it may be that various components of the total training subsystem design are being accomplished by different organizations. The oversight process for ET needs to confirm that the design of the ET component is not occurring in isolation from the design of the total training system and the prime item system.

5. Are ET requirements being identified through the application of ETR analysis procedures to the task analysis data? It is critical at this phase of the analysis that appropriate criteria are collected to differentiate those

training requirements which will be satisfied by ET from training requirements to be achieved through other components of the total training system. The oversight process must carefully review the rationale and its application to the task analytic data for this differentiation. Task nomination should be based on a careful assessment of perishability and criticality criteria, in addition to constraints imposed by overall training system decisions.

6. Is the decision making process which reviews the overall feasibility of implementing the identified ET requirements occurring? This process must not be unrealistically constrained by prime item system parameters and design considerations. In other words, oversight is appropriate to assure that ET emphases have an appropriate weight in the overall prime item system design process.

APPENDIX C

LIST OF ABBREVIATIONS AND ACRONYMS

AMC	US Army Materiel Command
AMSAA	Army Materiel Systems Analysis Activity
ARTEP	Army Training and Evaluation Program
AS	Acquisition Strategy
ASAP	Army Streamlined Acquisition Process
ASARC	Army Systems Acquisition Review Council
BDP	Battlefield Development Plan
CBTDEV	Combat Developer
CE	Continuous Evaluation
CEP	Concept Evaluation Program
CTEA	Cost and Training Effectiveness Analysis
DCP	Decision Coordinating Paper
DOT&E	Director, Operational Test and Evaluation
DSARC	Defense Systems Acquisition Review Council
DTEA	Developmental Training Effectiveness Analysis
DTP	Detailed Test Plans
ET	Embedded Training
EUT&E	Early User Test and Experimentation
FDTE	Force Development Test and Experimentation
FOT&E	Follow-on Operational Test and Evaluation
I&KP	Instructor and Key Personnel
IAW	In accordance with
IEP	Independent Evaluation Plan
IER, IERs	Independent Evaluation Report(s)
IOC	Initial Operational Capability
IOE	Initial Operational Evaluation
IPR	In-Process Review
IUT&E	Initial User Test and Evaluation
JDT	Joint Development Test
JMSNS	Justification for Major System New Start
JWG	Joint Working Group
LCSMM	Life Cycle Systems Management Model
MAA	Mission Area Analysis

MAATAG	Mission Area Analysis Test Advisory Group
MADP	Mission Area Development Plan
MADP	Materiel Acquisition Decision Process
MANPRINT	MANpower and PeRsonnel INTegration
MARB	Materiel Acquisition Review Board
MATDEV	Materiel Developer
MEP	Master Evaluation Plan
MOS	Military Occupational Specialty
MSC	Materiel Systems Command
NDI	Non-Development Item
O&O	Operational and Organizational Plan
OT	Operational Test
OTEA	Operational Test and Evaluation Agency
OTP	Outline Test Plan
OTRR	Operational Test Readiness Review
OTRS	Operational Test Readiness Statements
P3I	Preplanned Product Improvement
PDM	Program Decision Memorandum
PFTEA	Post-Fielding Training Effectiveness Analysis
PIP	Product Improvement Proposal (Program)
PPQT	Preproduction Qualification Test
PQT	Production Qualification Test
PTEA	Preliminary Training Effectiveness Analysis
QT	Qualification Test
RAM	Reliability, Availability, and Maintainability
RFP	Request for Proposals
ROC	Required Operational Capability
SAT	Systems Approach to Training
SCP	System Concept Paper
SME, SMEs	Subject Matter Expert(s)
SSP	System Support Package
SWG	Special Working Group
T&E	Test and Evaluation

TDP	Test Design Plan
TDS	Training Development Study
TDR, TDRs	Training Device Requirement(s)
TDY	Temporary Duty
TEA	Training Effectiveness Analysis
TECOM	US Army Test and Evaluation Command
TEMP	Test and Evaluation Master Plan
TFT	Technical Feasibility Test
TIE	Technical Independent Evaluator
TIR	Test Incident Report
TISC	Technology Integration Steering Committee
TIWG	Test Integration Working Group
TMEC	TRADOC Materiel Evaluation Committee
TR	Test Report
TRADOC	US Army Training and Doctrine Command
TSARC	Test Schedule and Review Committee
TT	Technical Test
TT&E	Technical Test and Evaluation
TTRR	Technical Test Readiness Review
UT	User Test
UT&E	User Test and Evaluation
UTRR	User Test Readiness Review